of aperture 6 mm.; 5½ whorls. It will be figured in the present volume of the Manual of Conchology.

Another species of unusual interest is a fossil *Partulina* which was discovered by Dr. Cooke several years ago in a superficial road cutting at the junction of Manoa road with the upper road, back of Rocky Hill, which terminates the western ridge of Manoa valley.

Only one *Partulina* has been known in Oahu hitherto, that being *P. dubia* (Newc.). The present form, which I will call *Partulina montagui* n. sp., is not related to *dubia*, but to such Molokaian species as *P. dwightii* Newc. I regard these two *Partulinas* and the few Oahuan species of *Laminella* as stragglers from the Molokai-Lanai-Maui evolution-center, which reached Oahu before the subsidence of a ridge which I believe formerly connected the islands.

P. montagui cannot have been extinct for any great length of time, as the specimens occur in the humus, only buried a few inches below the turf. Probably the forest disappeared from where they are found not more than seventy-five to a hundred years ago. It must have been extinct in the early fifties, or it would surely have been found by Newcomb, Gulick or Emerson.

The shell is sinistral, perforate, ovate-conic, with acuminate spire, thick and solid, sculptured with close, irregular wrinkles, the last whorl malleated; whorls 7⅓, the upper ones nearly flat, the rest convex; suture superficial. Outer and basal margins of the peristome expanded, thick, heavily thickened within; columellar margin thick; columellar fold thick and moderately prominent.

Length 25, diam. 14 mm. (108181 A. N. S. P.).

Length 24.7, diam. 12.5 mm. (111 coll. Irwin Spalding).

Length 26.9, diam. 13.1 mm. (33581 B. P. Bishop Mus.).

THE UNIONE FAUNA OF THE GREAT LAKES.

BY BRYANT WALKER, SC. D.

(*Continued from page 34.*)

Now, according to the geologists, some time about the beginning of the Cretaceous Period there was a great sinking of the land in the Gulf region. It extended from central Texas east to the middle of Alabama, and in a triangular shape north to southern Illinois. It

broke through and separated the ancient Cumberland Plateau, which prior to that time extended continuously from the eastern mountains into western Texas. It admitted the sea to a point, as above stated, north of the present junction of the Ohio and Mississippi, and during nearly the whole of Tertiary times there was a body of salt water between the western highlands and the eastern portion of the Cumberland Plateau, in what is now Tennessee and Kentucky. This invasion of the sea was, of course, an absolute barrier to any communication between the Unione faunas of the two regions.

The evidence afforded by the present distribution of the species of the group, to which these species belong, shows that its center of distribution, as affecting the present fauna, was in the southwest. Not only is the southwest the region of the greatest variation in the species of this group, but, while it extends from Texas easterly along the Gulf States as far as Alabama, and even into Georgia and Florida, and extends north through the entire Mississippi Valley to the Appalachians on the east and the Arctic regions on the north, there is no representative of that group found to-day, so far as records show, in any part of the Tennessee Valley. The inference to be drawn from this fact is that the group originated in the west, and after the great landslide of Cretaceous times. Another example, bearing upon the same general fact, is the distribution of the group, of which the well-known *Quadrula rubiginosa* is a leading example. If we are to rely upon the proposition that the center of distribution is the region where there is the greatest abundance of individuals and of specific forms, it would seem certain that this group originated in the southwest and from thence spread eastward to its present distribution. But *Quadrula rubiginosa*, like *Lampsilis luteola*, is not found in the Tennessee Valley. Its distribution through the Gulf States is similar to that of the *Lampsilis*, and its distribution north through the Mississippi and Ohio valleys is exactly the same. Like *luteola*, it is found in the Lake Erie, but for some reason, that we do not now know, no form of that group ever succeeded in obtaining a foothold at any time in the northern Atlantic fauna.

If the inferences to be drawn from these facts and others like them are to be relied upon, there would seem to be good reason to infer that the emigration, which was the beginning of the Atlantic fauna, took place after the invasion of the sea in the Mississippi

Valley in Cretaceous times, and would probably seem to have been in later Cretaceous or early Tertiary times.

It would seem most probable that the primitive ancestral form of the *complanatus* group also reached the Atlantic region by the same northern route. Although the greatest diversity of forms belonging to it is now peculiar to the southeastern Atlantic states and, under the axiom already quoted, would seem to indicate that that region was the center of distribution of the group, the weight of evidence is against it.

As has already been stated, the invasion of the sea up the Mississippi Valley in Cretaceous times prevented any emigration towards the east from the southwest during nearly the whole of the Tertiary Period. Moreover, during the greater part of that time this region itself was covered by the sea. The invasion of the southeastern States by the present Unione fauna must necessarily have been, comparatively speaking, a recent one. Had it been coincident with the advance of the southwestern fauna that now occupies the Gulf States to the west of the Alabama River, there would, no doubt, be some evidence left in the present fauna of those States. But there is none. The present distribution of the group shows that it stops abruptly before reaching the Alabama River. With one exception, the group is not represented in the fauna of the Alabama at the present time, nor is it found at all in any of the Gulf States west of that river.

The exuberant variability of the group in the southeastern States at the present time would also seem to indicate that it is comparatively a new comer, and that it has not even yet had time to settle down to stable lines of development.

On the other hand, the homogeneity of the group as a whole, in spite of its extreme variability within the group limits, would indicate that it is of ancient origin. The extraordinary range of the typical species, from Lake Superior to the Atlantic and south to Georgia, is evidence in the same direction.

Taking everything into consideration it must be said that, with the exception of a comparatively small number of species that from one cause or another have been able to get into the South Atlantic States from the faunas of the Alabama and Tennessee systems, all the evidence goes to show that the characteristic fauna of that region has been derived from the north.

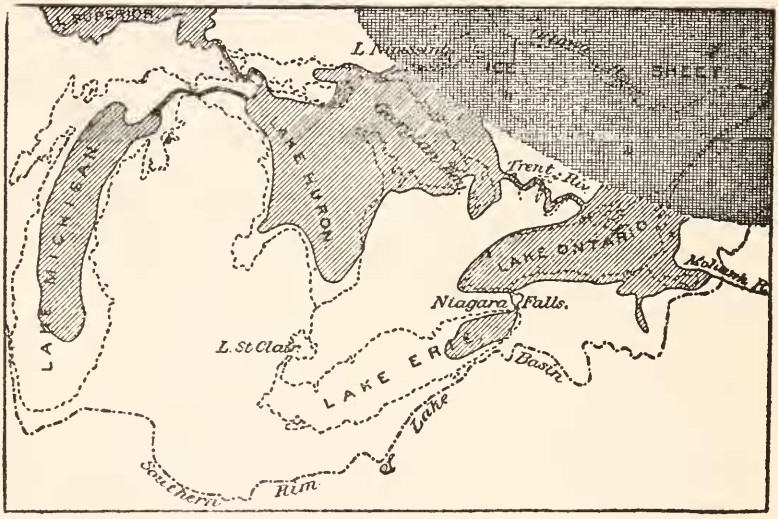
II.

Assuming, then, that the Atlantic fauna, in its inception, was derived from a very early immigration from the west, there has been abundance of time for it to become specifically differentiated. Unless the unanimous opinion of the geologists of this country is entirely wrong, it is clear that whatever remnants of this ancient fauna were left along the course of this ancient track of migration towards the east in the region of the Great Lakes were wiped out absolutely by the invasion of the ice during the Glacial Period. Whatever may be said in regard to there being any geological evidence of an unglaciated area in north central British America, there would seem to be no doubt but that the region of the Great Lakes was the very center of the destruction wrought by the invasion of the ice. As has already been said, the entire system of drainage was absolutely changed. The old system was wiped out and a new and radically different one established. The Great Lakes themselves are entirely the result of changes in the earth's surface, wrought by the invasion and subsequent retreat of the ice. It is stated by Grabau that at Detroit the present surface is 130 feet above the pre-glacial surface, and that the ancient bed of the pre-glacial Cuyahoga at Cleveland is 400 feet below the bed of the present river, and, as has already been stated, the present bed of the Ohio is 150 feet above that of its ancient predecessor. According to Taylor (4) the front of the retreating ice-cap at Toledo, Detroit and Port Huron stood in two hundred feet of water. There is no part of the present area occupied by the Great Lakes and their tributaries that was not included within this area of glacial destruction. We may assume, therefore, that whatever fauna was in existence prior to the advent of the ice was wiped out absolutely from this region. This being assumed, the present extension of the Atlantic fauna to the northwest must be looked for in the various systems of temporary drainage that were established in the post-glacial times prior to the final establishment of the existing St. Lawrence system. There can be no doubt but that here and there in the Atlantic region, north of the glaciated area, there were places in which the remnants of the ancient fauna were preserved, and that, from these harbors of refuge, upon the retreat of the ice, the Unionidæ were able to re-people the barren waters of the new land.

The ice in the lower lake region retreated towards the north and

east, and in the first stage, as soon as the edge of the glacier had passed the height of land north of the Mississippi and Ohio Valleys, the waters were impounded, and in the southern end of the present Lake Michigan and in the western ends of the present Lake Superior and Lake Erie, but at a much higher level, were formed the first post-glacial lakes. Lake Maumee, at that time bounded on the north and east by the ice, found an outlet into the Ohio through the present valley of the Maumee and the Wabash. Upon the further retreat of the ice to such an extent that a way was opened for an

Fig. 4.



outlet towards the east, there were successively different systems established. One of the earliest of these (Fig. 4) was that known as the Trent outlet, which extended, as shown by the figure, from the eastern end of Georgian Bay southeast across Ontario into Lake Ontario. From the south side of Lake Ontario the water flowed through the present Mohawk Valley into the Hudson.

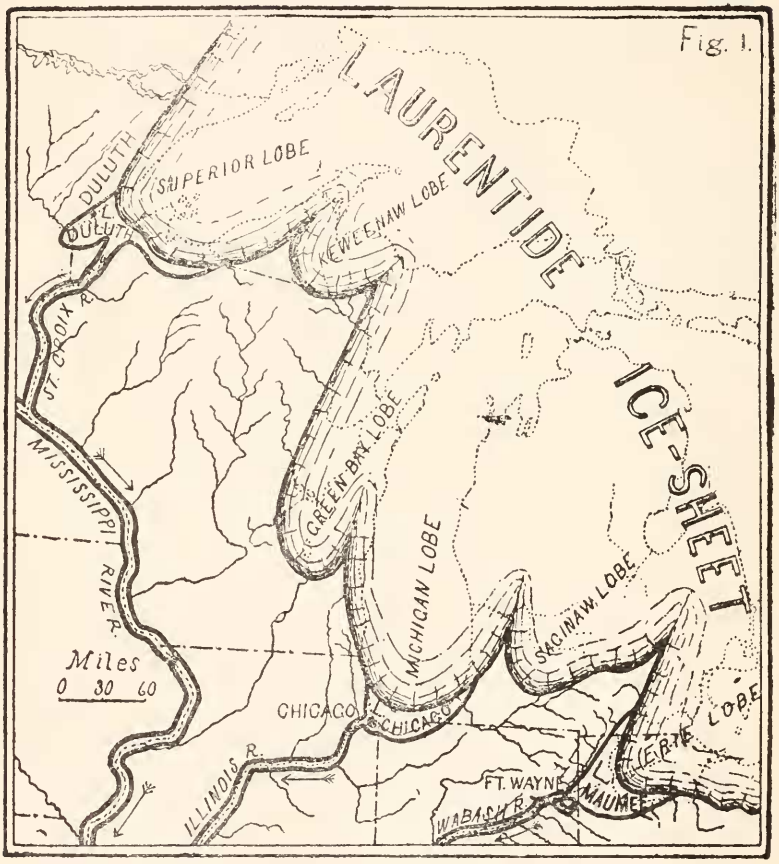
The opening of this new outlet to the east so lowered the water that it was diverted from its former course through Lake Erie, and the present area occupied by that lake became dry land, except for such local drainage as might be necessarily incident to the region

itself. Later, another outlet was formed, known as the Nipissing outlet, at a still lower level, which resulted in the closing of the Trent outlet, and the establishment of a new one along the present valley of the Ottawa into the St. Lawrence. When the Nipissing outlet was first established, however, there had been a lowering of the land toward the east, and the sea had invaded the region to a considerable distance up the Ottawa Valley beyond the present city of Ottawa, and into Lake Ontario. Later, with the subsequent rising of the land, the Nipissing outlet flowed through the present Ottawa Valley into what is now known as the St. Lawrence. It seems reasonably certain that the western invasion of the Great Lake region of the Atlantic fauna was through either the Trent or the Nipissing outlet, and the probability is in favor of the Trent outlet, because that was always entirely fresh water, and there would seem to be every probability, from what we know of the inter-glacial extension of the Mississippi fauna into this region, that the post-glacial lakes were almost immediately invaded by the fish and with them the Unionidæ of the regions to the south and to the east. So far as the particular question here involved is concerned, it is immaterial by which of these routes the invasion took place. Both of them began on the west, at the Georgian Bay, and afforded a continuous waterway from the east to the northwest. Both of these outlets were antecedent to the establishment of an outlet through the Niagara River. That no invasion from the east of the Atlantic fauna could have taken place by that route is clear for the reason that there was always, to a greater or less degree, a falls in the Niagara River, which was an absolute barrier to any migration of the fish upstream from the east, and that there was no such invasion from the east by that route is shown by the fact that in the case of the *Unio complanatus*, there is no evidence to show that it ever reached Lake Erie. The remarkable agreement between the present range of *Unio complanatus* and the route of these earlier post-glacial outlets is evidently more than a mere coincidence. If, then, the invasion was through either the Trent or the Nipissing outlet into Georgian Bay, it is easy to see how the species spread along the north shore of the Georgian Bay into the St. Mary's, and from thence into the eastern Lake Superior, without getting either into Lake Erie, Lake St. Clair, or the lower part of Lake Huron.

III.

As has already been stated, the first post-glacial lakes formed by the retreat of the ice in this region were in the south end of Lake Michigan and the west ends of Lake Erie and Lake Superior,

FIG. 5.



bounded on the south by the height of land and on the north and east by the ice cap.

Glacial Lake Erie (Lake Maumee), at that period, drained southwest into the Ohio, and as I have already shown in my paper on

"The Distribution of the Unionidæ in Michigan," (5) there can be no doubt but that almost immediately there was an invasion of this lake from the Ohio of the dominant species of that region, and it is unnecessary at the present time to discuss that subject further. In the same way, and at about the same time, the St. Croix outlet of Lake Duluth into the Mississippi would have given an opportunity for an invasion of that region by the Mississippian fauna. And it would seem probable that the occurrence of *Lampsilis luteola* and *superioriensis* in the western portion of Lake Superior at the present time is to be accounted for in that way.

(*To be concluded.*)

PUBLICATIONS RECEIVED.

THE GIANT SPECIES OF THE MOLLUSCAN GENUS LIMA OBTAINED IN PHILIPPINE AND ADJACENT WATERS. By Paul Bartsch (Proc. U. S. Nat. Mus., Vol. 45, pp. 235–240, pls. 12–20, 1913). The giant *Limas* here described were obtained during the Philippine cruise of the fisheries steamer "Albatross," 1907–1910. They occur only in deep water—161 to 559 fathoms. "They are by no means abundant or universally distributed, for of the 369 dredgings made in more than 100 fathoms only 18 yielded these mollusks." *Lima* (*Callolima*) *smithi* measures as follows: Alt. 175 mm., lat. 118 mm., diam. 48 mm. The type was dredged off Baliscasag Island in 432 fathoms. *L.* (*Callolima*) *philippinensis* measures, alt. 177, lat. 111, diam. 37; dredged off the outer Tayabas Light in 190 fathoms. *L.* (*Callolima*) *rathbuni* was obtained from eight stations at depths ranging from 161 to 226 fathoms, the largest specimen measuring, alt. 208 mm., lat. 156 mm., diam. 59 mm. *L.* (*Acesta*) *celebensis* has an alt. of 159 mm., and was dredged south of North Island, Buton Strait, in 519 fathoms. The paper is a valuable contribution to our knowledge of the deep-sea mollusca.—C. W. J.

THE PHILIPPINE MOLLUSKS OF THE GENUS DIMYA. By Paul Bartsch (Proc. U. S. Nat. Mus., Vol. 45, pp. 305–307, pls. 27 and 28, 1913). *Dimya lima* was found attached to the shells of *Lima* (*Callolima*) *smithi* and *L.* (*Callolima*) *dalli*, in 161 to 281 fathoms.

MOLLUSQUES DE LA FRANCE ET DES RÉGIONS VOISINES. Par A. Vayssière, professeur à la Faculté des sciences de Marseille, et